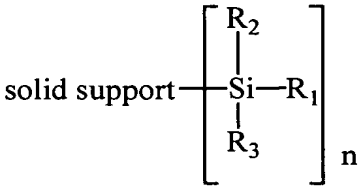
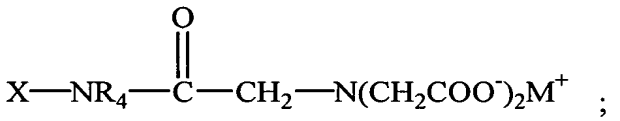
CLAIMS

1. A method for isolating target material from a starting material comprising:

(a) contacting the starting material with a composition selected from the group consisting of:



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

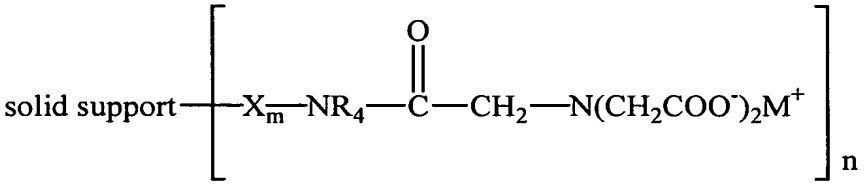
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥ 1;

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

n is an integer ≥1; and

m is 0 or 1;

to form a complex between at least a portion of the target material and the composition.

2. The method of claim 1, wherein X is $-(CH_2)_3-$, R_4 is H, and M^+ is Ni(II).

3. The method of claim 1, further comprising:

(b) washing the complex of step (a); and

(c) eluting the target material.

4. The method of claim 1, wherein the target material is selected from the group consisting of polypeptide, a polynucleotide, and an endotoxin.

5. The method of claim 1, wherein the target material is a polypeptide.

6. The method of claim 5, wherein the polypeptide comprises an affinity tag.

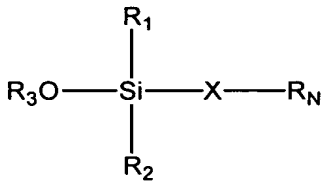
7. The method of claim 6, wherein the affinity tag comprises a polyhistidine tag.

8. The method of claim 5, wherein the polypeptide comprises a detectable label.

9. The method of claim 8, wherein the detectable label is selected from the group consisting of a fluorophore and a dye, or a combination thereof.

10. A method for separating target material from non-target material in a starting material comprising:

(a) contacting the starting material with a composition under conditions suitable to form a complex between the composition and non-target material, the composition comprising:



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

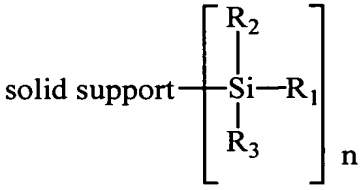
R_1 is a hydrocarbon moiety, or a substituted hydrocarbon moiety;

R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety, or a substituted hydrocarbon moiety; and

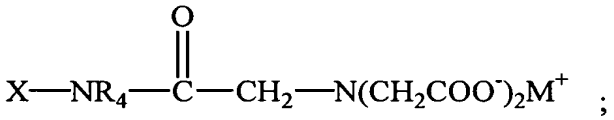
R_N is NH_2, NHR_{N1}, $NR_{N1}R_{N2}$, or $NR_{N1}R_{N2}R_{N3}$, wherein R_{N1}, R_{N2}, and R_{N3} are independently selected from a hydrocarbon moiety with up to a six-carbon main chain, a substituted hydrocarbon moiety with up to a six-carbon main chain, or a hydrogen atom;

(b) collecting the flow through comprising target material;

(c) contacting the target material of step (b) with a second composition under conditions suitable to form a complex between the support and the target material, the second composition selected from the group consisting of



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

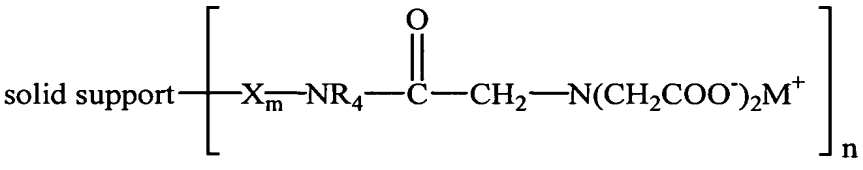
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥ 1;

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

n is an integer ≥1; and

m is 0 or 1.

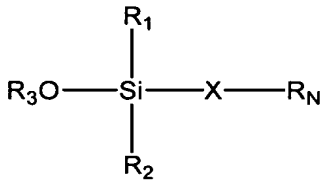
11. The method of claim 10, wherein the solid support is selected from the group consisting of silica and magnetic silica particles.

12. The method of claim 10, wherein the support of step (c) reversibly binds the target material.

13. The method of claim 10, wherein the target material is selected from the group consisting of a polypeptide, a nucleic acid, and an endotoxin.

14. A method for isolating membrane-associated proteins from a starting material comprising

(a) contacting the starting material with a composition under suitable conditions to form a complex between the membranes and the composition, wherein the starting material comprises an in vitro expression system comprising microsomal membrane vesicles, and wherein the composition comprises:



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_1 is a hydrocarbon moiety, or a substituted hydrocarbon moiety;

R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety, or a substituted hydrocarbon moiety; and

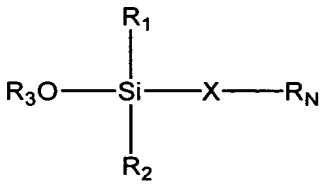
R_N is NH_2, NHR_{N1}, $NR_{N1}R_{N2}$, or $NR_{N1}R_{N2}R_{N3}$, wherein R_{N1}, R_{N2}, and R_{N3} are independently selected from a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom.

15. The method of claim 14, wherein R_{N1}, R_{N2}, and R_{N3} are independently selected from the group consisting of an alkyl moiety of up to six carbon atoms in a longest chain, a substituted alkyl moiety of up to six carbon atoms in a longest chain, and a hydrogen atom.

16. The method of claim 14, further comprising contacting the complex of step (a) with a nonionic detergent.

17. A method for separating target material from non-target material in a starting material comprising:

(a) contacting the starting material with a composition to form a complex between the target material and the composition, wherein the composition comprises:



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_1 is a hydrocarbon moiety, or a substituted hydrocarbon moiety;

R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety, or a substituted hydrocarbon moiety; and

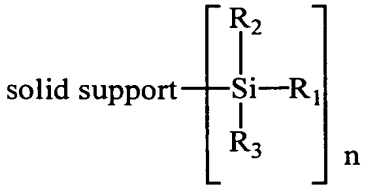
R_N is NH_2, NHR_{N1}, $NR_{N1}R_{N2}$, or $NR_{N1}R_{N2}R_{N3}$, wherein R_{N1}, R_{N2}, and R_{N3} are independently selected from a hydrocarbon moiety with up to a six-carbon main chain, a substituted hydrocarbon moiety with up to a six-carbon main chain, or a hydrogen atom;

wherein at least a portion of the non-target material does not form a complex with the composition, wherein the non-target material comprises a polypeptide containing a prosthetic heme group.

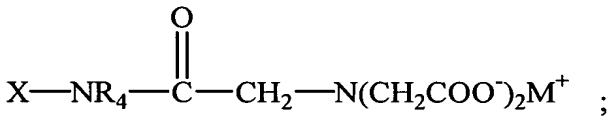
18. The method of claim 17, wherein R_{N1}, R_{N2}, and R_{N3} are independently selected from the group consisting of an alkyl moiety of up to six carbon atoms in a longest chain, a substituted alkyl moiety of up to six carbon atoms in a longest chain, and a hydrogen atom.

19. The method of claim 17, wherein the non-target material is selected from the group consisting of hemoglobin and myoglobin.

20. A kit for separating target material from non-target material in a starting material comprising a composition comprising selected from the group consisting of



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

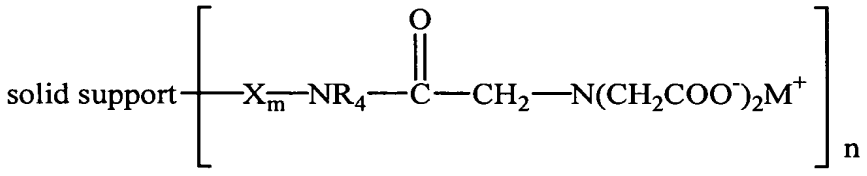
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥1;

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

n is an integer ≥1; and

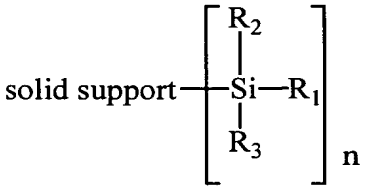
m is 0 or 1.

21. The kit of claim 20, wherein X is $-(CH_2)_3-$, R_4 is H, and M^+ is Ni(II).

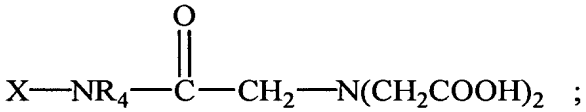
22. The kit of claim 20, further comprising at least one of a binding buffer, a wash buffer, and an elution buffer.

23. A method for reducing metal ions in a fluid comprising:

(a) contacting the fluid with a composition to form a complex between the metal ions and the composition, the composition comprising:



wherein R_1 is



;

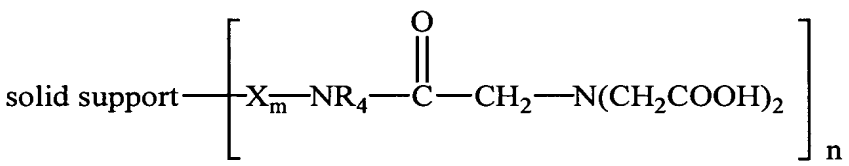
X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom; and

n comprises an integer ≥1;

and



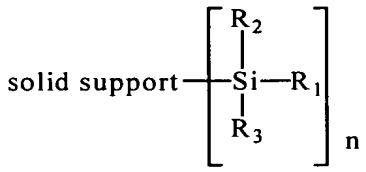
wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

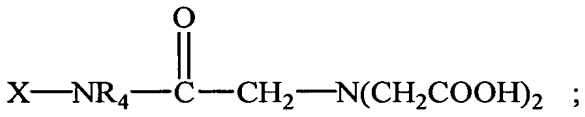
n is an integer ≥1; and

m is 0 or 1.

24. The method of claim 23, wherein the composition is



wherein R_1 is



X is $-(CH_2)_3-$;

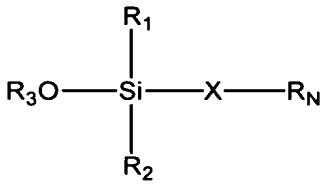
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrogen atom; and

n comprises an integer ≥1.

25. A method for removing cells from a starting material comprising:

(a) contacting the starting material with a composition under conditions suitable to form a complex between the cells and the composition, the composition comprising:



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_1 is a hydrocarbon moiety, or a substituted hydrocarbon moiety;

R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety, or a substituted hydrocarbon moiety; and

R_N is NH_2, NHR_{N1}, $NR_{N1}R_{N2}$, or $NR_{N1}R_{N2}R_{N3}$, wherein R_{N1}, R_{N2}, and R_{N3} are independently selected from a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom.

26. The method of claim 25, wherein R_{N1}, R_{N2}, and R_{N3} are independently selected from the group consisting of an alkyl moiety of up to six carbon atoms in a longest chain, a substituted alkyl moiety of up to six carbon atoms in a longest chain, and a hydrogen atom.

27. The method of claim 25, wherein R_{N1}, R_{N2}, and R_{N3} are independently selected from an alkyl moiety of up to six carbon atoms in a longest chain, a substituted alkyl moiety of up to six carbon atoms in a longest chain, and a hydrogen atom.

28. The method of claim 25, wherein the conditions comprise the presence of methanol, ethanol, or isopropanol in a concentration of at least about 1% (v/v).

29. The method of claim 25, wherein the conditions comprise the presence of isopropanol in a concentration of at least about 15% (v/v).

30. The method of claim 25, wherein the cells are bacterial cells.

31. A method for detecting protein in a starting material comprising:

(a) contacting the starting material with a composition comprising a solid support comprising an immobilized metal chelating agent to form a complex between the protein and the composition;

(b) contacting the complex of step (a) with a protein-complexing detectable label to form a labeled protein complex;

(c) washing the support to remove uncomplexed label;

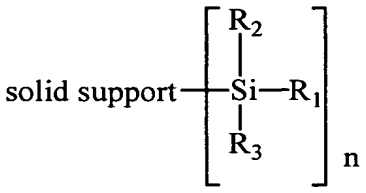
(d) detecting the labeled protein complex.

32. The method of claim 31, further comprising:

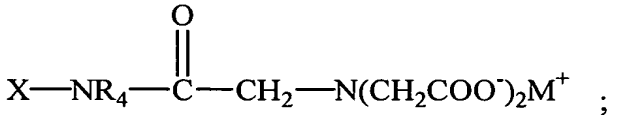
(e) measuring complexed label; and

(f) determining the concentration of the protein by correlating the amount of complexed label of step (e) with a known quantity of labeled protein complex.

33. The method of claim 31, wherein the metal-modified solid support is selected from the group consisting of



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

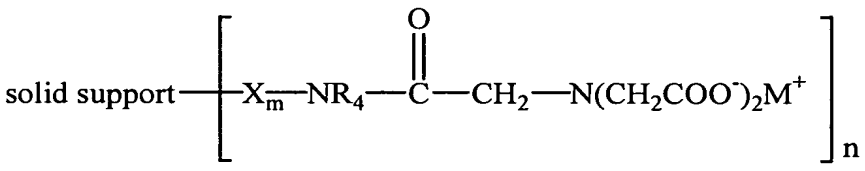
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥1;

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

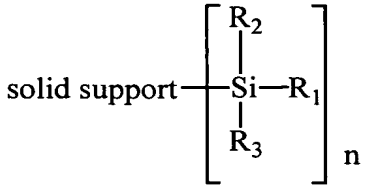
n is an integer ≥ 1; and

m is 0 or 1.

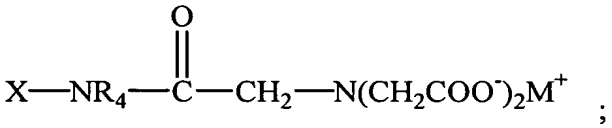
34. The method of claim 31, wherein the detectable label is selected from the group consisting of a fluorophore and a dye, or a combination thereof.

35. A method for separating nucleic acids from a starting material:

(a) contacting the starting material with a composition under suitable conditions to form a complex between the nucleic acid and the composition, the composition selected from the group consisting of



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

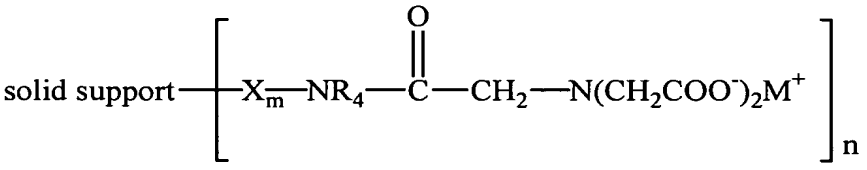
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥1

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

n is an integer ≥ 1; and

m is 0 or 1.

36. The method of claim 35 further comprising:

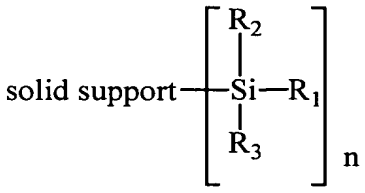
(b) eluting the nucleic acid of step (a).

37. The method of claim 35, wherein the nucleic acid comprises tRNA.

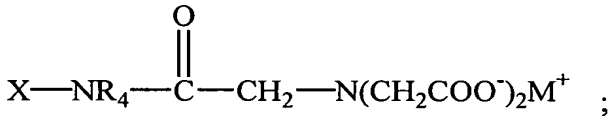
38. The method of claim 35, wherein the metal ion is nickel.

39. A method for assaying the activity of an enzyme in a starting material, the enzyme capable of catalyzing the conversion of a substrate to a product, comprising:

(a) contacting the starting material with a composition to form a complex between the enzyme and the composition, the composition selected from the group consisting of



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

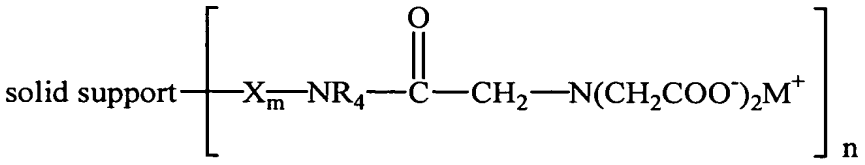
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥ 1;

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

n is an integer ≥ 1; and

m is 0 or 1;

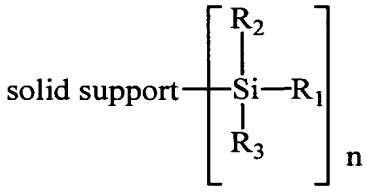
(b) contacting under suitable reaction conditions the complex of step (a) with a substrate for the enzyme; and

(c) detecting a decrease in substrate or an increase in product.

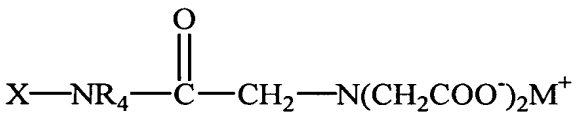
40. The method of claim 39, wherein the enzyme comprises a polyhistidine tag.

41. A method for separating phosphoproteins from a starting material comprising:

(a) contacting the starting material with a composition to form a complex between the phosphoprotein and the composition, the composition selected from the group consisting of



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

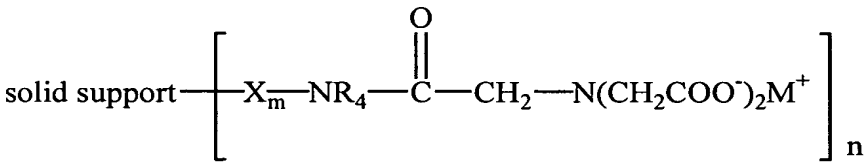
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥ 1;

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

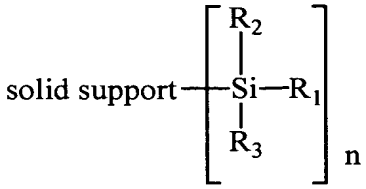
M^+ is a metal ion;

n is an integer ≥ 1; and

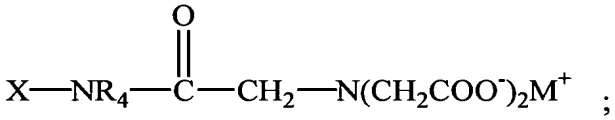
m is 0 or 1;

wherein the metal ion is selected from the group consisting of iron (III) or gallium (III).

42. A kit for separating phosphoproteins from a starting material comprising a composition selected from the group consisting of



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

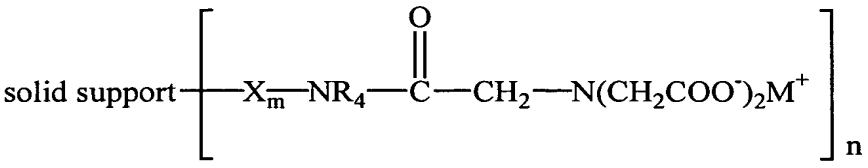
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥1;

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

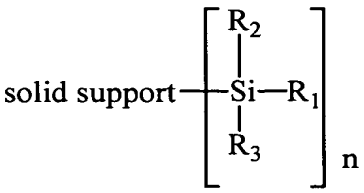
n is an integer ≥ 1; and

m is 0 or 1;

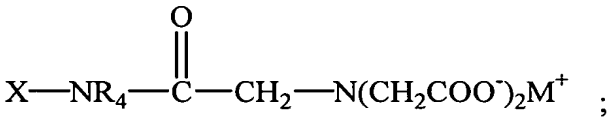
wherein the metal ion is selected from the group consisting of iron (III) and gallium (III).

43. The kit of claim 42, further comprising at least one of a binding buffer, a wash buffer, and an elution buffer.

44. A device for purifying proteins comprising, disposed within the device, a composition selected from the group consisting of:



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

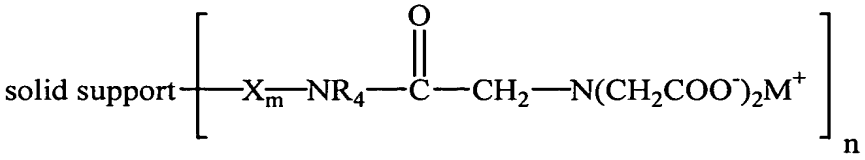
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥1;

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

n is an integer ≥ 1; and

m is 0 or 1.

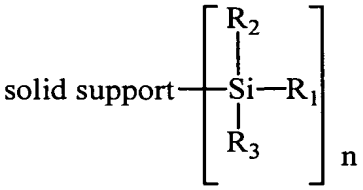
45. The device of claim 44, wherein the device comprises a pipet tip.

46. A kit for isolating target material from a starting material comprising the device of claim 44.

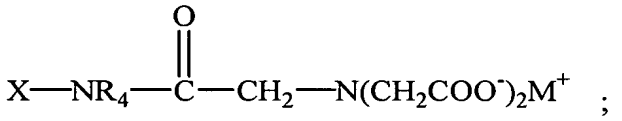
47. The kit of claim 46, further comprising at least one of a binding buffer, a wash buffer, and an elution buffer.

48. A method for sequential fractionation of polypeptides in a starting material having at least least two different types of polypeptides comprising:

(a) contacting the starting material with a composition to form a complex between the polypeptides and the composition, the composition selected from the group consisting of



wherein R_1 is



;

X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

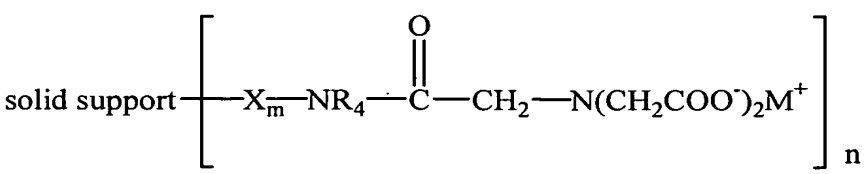
R_2 and R_3 are independently selected from R_1, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-$Y_1Y_2Y_3$, wherein Y_1, Y_2 and Y_3 are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

n is an integer ≥1

and



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R_4 is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M^+ is a metal ion;

n is an integer ≥ 1; and

m is 0 or 1;

wherein the metal ion is selected from the group consisting of copper and cobalt, to form a complex between the polypeptides and the composition; and

(b) sequentially eluting the polypeptides by contacting the complex with at least one elution buffer that achieves an effect selected from the group consisting of altering the pH, altering the concentration of at least one salt, providing an organic solvent, altering ionic conditions, altering hydrophobic conditions, and providing a chelating agent, or combinations thereof.